

University of Bahrain
College of Information technology
Department of Computer Engineering

Test (1)

Student Name
I.D. No.
Section

Course Title: Digital Logic
Course number: ITCE 202-ITCE 250
Semester: 1
Academic Year: 2015/2016
Duration : 1 hour
Date: 28th October 2015

Read the following before you start:

1. Write your name, ID and section number
2. Answer all questions.
3. Write your answers on the attached sheets only.

Question	Mark	Mark attained
1	25	25
2	25	25
3	25	25
4	25	25
Total	100	100

Question [1]: [25 mark]

- (a) What is the range of signed binary numbers to be represented in 2's complement using 6-bit word length? [3 marks]

$$\text{range} = [-2^5, +2^5 - 1] = [-32, +31] \quad [3 \text{ marks}]$$

- (b) Perform the following operation for in 2's complement using 6-bit word. [5 marks]

$$(-12)_{10} - (15)_{10} =$$

$$\begin{array}{r} -12 \Rightarrow +110100 \\ + -15 \Rightarrow +110001 \\ \hline 001001 \end{array} \quad \begin{array}{r} 16 \ 8 \ 4 \ 2 \ 1 \\ 12 \Rightarrow 0 \ 1 \ 1 \ 0 \ 0 \\ 15 \Rightarrow 0 \ 1 \ 1 \ 1 \ 1 \\ \hline 10000 \\ 10000 \\ \hline 01000 \end{array}$$

Correct answer, no overflow

- (c) Convert the following numbers showing all steps. [3 marks each, 12 marks]

$$(1B5.2)_{16} = (665.1)_8$$

$$(1B5.2)_{16} = (0001 \ 1011 \ 0101 . 0010)_2$$

$$(75)_{10} = (1000 \ 0110)_{7-3-2-1}$$

$$(75)_{10} = (1000 \ 0110)_{7-3-2-1}$$

$$(56)_{10} = (1000 \ 1001)_{\text{excess-3}}$$

$$(56)_{10} = (1000 \ 1001)_{\text{excess-3}}$$

$$(11011100)_{2's \text{ complement}} = (11011011)_{1's \text{ complement}}$$

$$\begin{array}{r} 1101100 \\ - 00101 \\ \hline 1011011 \end{array}$$

- (e) Convert and add the following numbers in Binary Coded Decimal BCD. [5 marks]

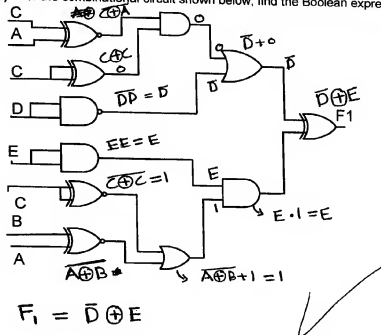
$$(85)_{10} + (36)_{10} =$$

$$\begin{array}{r} (85)_{10} \Rightarrow 1000 \ 0101 \\ + (36)_{10} \Rightarrow 0011 \ 0110 \\ \hline 1000 \ 0110 \\ \hline 1011 \ 1011 \quad \rightarrow \text{does not exist in BCD, add 6} \\ + 0110 \ 0110 \\ \hline 0001 \ 0010 \ 0001 \end{array}$$

1 2 1

Question [2] : [25 mark]

- (a) For the combinational circuit shown below, find the Boolean expression for the output F1.



- a- Use Boolean algebra to Simplify the following:

$$\begin{aligned}
 & a\bar{b}c + adc + \underline{bdc} + \bar{b}c \\
 & = a\bar{b}c + \overbrace{adc}^{\text{consensus term}} + \underline{bdc} + \bar{b}c \\
 & = a\bar{b}c + bdc + \bar{b}c \\
 & = \bar{b}c(a+1) + bdc \\
 & = \bar{b}c(1) + bdc = \bar{b}c + bdc \\
 & = c(\bar{b} + bd) = c(\bar{b} + b)(\bar{b} + d) = c(1)(\bar{b} + d) \\
 & = c\bar{b} + cd
 \end{aligned}$$

Handwritten notes on the right:

- ~~etc~~
- ~~acdc~~
- $dc(ac) = adc$

3

Question [3]: [25 mark]

We want to construct the truth table of a "disk spinning" animation circuit for a CD player. The input to the circuit will be a 3-bit binary number $A_1A_2A_3$. The animation will appear on the top four segment of the 7-segment display shown in Figure (1), i.e. on segment **a**, **g**, **e**, **f**. The pattern is shown in Figure (2).

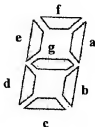


Figure (1) 7-segment display

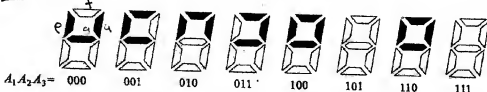


Figure (2) Pattern of the required animation.

- Construct a truth table of the circuit.
- Write the minterm expansion of segment **a** both in decimal form and algebraic form.
- Write the maxterm expansion of segment **g** in decimal form.
- Write the maxterm expansion of segment **e** in decimal form.

segments b, d, c are not considered

m	A_1	A_2	A_3	a	g	e	f	\bar{e}
0	0	0	0	1	1	1	0	0
1	0	0	1	0	1	1	1	0
2	0	1	0	1	0	1	1	0
3	0	1	1	1	1	0	1	1
4	1	0	0	1	1	1	1	0
5	1	0	1	0	0	0	0	1
6	1	1	0	1	1	1	1	0
7	1	1	1	0	0	0	0	1

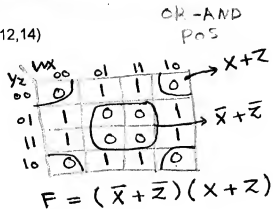
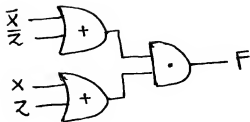
- $$a = \bar{A}_1\bar{A}_2\bar{A}_3 + \bar{A}_1A_2\bar{A}_3 + \bar{A}_1A_2A_3 + A_1\bar{A}_2\bar{A}_3 + A_1A_2\bar{A}_3$$

$$a = \sum m(0, 2, 3, 4, 6)$$
- $$g = \prod M(2, 5, 7)$$
- $$\bar{e} = \prod M(0, 1, 2, 4, 6)$$

Question [4]: [25 mark]

- a- Implement the following Boolean function with minimum number of gates using OR-AND implementation.

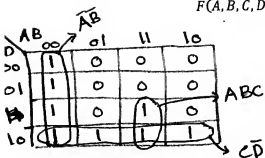
$$F(W, X, Y, Z) = \Sigma m(1, 3, 4, 6, 9, 11, 12, 14)$$



- b- Use K-map to simplify the following function then to implement it with a minimum number of gates using AND-OR implementation.

$$F(A, B, C, D) = \bar{A}\bar{B} + C\bar{D} + ABC + \bar{A}\bar{B}C\bar{D} + ABC\bar{D}$$

AND-OR
SOP



$$ABC \rightarrow 111x \rightarrow 1110, 1111$$

\downarrow \downarrow
 14 15

$$F = \bar{A}\bar{B} + C\bar{D} + ABC$$

